Pneumatic Vehicle Tires

The invention relates to pneumatic vehicle tires comprising a multi-ply carcass, which extends between two bead rings having associated bead apexes, a belt arrangement provided between the carcass plies and a tread strip and also rubber reinforcing plies arranged in the side wall regions, which take on a supporting function with a deflated tire.

Pneumatic vehicle tires of this kind are, for example, known from US-PS 5,368,082. By means of such tires it is possible, in the event of a tire puncture, to travel larger distances at adequate speed, even with a deflated tire, before repair of the tire or a tire change has to be effected. Such tires accordingly increase the safety in the event of a tire puncture and make it possible to reach the next repair shop without problem, so that undesired and also dangerous tire changing on roads with heavy traffic can be avoided.

The object of the present invention is to design a pneumatic vehicle tire of the initially named kind so that even in the deflated state a long distance can be traveled at an adequately high speed, so that the stiffening rubber plies in the side walls do not disturbingly impair the driving comfort of the tire operated at normal pressure and so that the tire weight remains as low as possible.

This object is satisfied in accordance with the invention essentially in that a first rubber reinforcing ply is arranged radially inside a first carcass ply, a second rubber reinforcing ply is arranged between the first carcass ply

and a second carcass ply, and a third rubber reinforcing ply is arranged
between the second carcass ply and a third carcass ply; in that the three
rubber reinforcing plies extend, starting from the bead apex region with
mutually displaced ends, up to and beneath the edge region of the belt
ply; in that the three rubber plies have a different height in the radial
direction and different thicknesses over the height of the side wall; and in
that, with a bead apex provided, the radially inner end regions of all three
rubber plies are disposed on the axially inner side of the bead apex.

All three rubber reinforcing plies have different thicknesses over their
radial height, with preferably the middle rubber reinforcing ply having a
lower thickness in comparison to the inner and outer rubber reinforcing
plies over at least a predominant part of the height of the side wall.

All rubber reinforcing plies and also the bead apex preferably consist of
the same rubber mixture.

As a result of the choice of the rubber mixture, of the thickness profile of
the rubber reinforcing plies and of the differing hardening times of these
rubber reinforcing plies in dependence on the position of the rubber
reinforcing plies in the tire, ideal values are obtained with respect to the
long running characteristics with the deflated tire, in particular when, in
the finished tire, the modulus of elasticity E^* of the rubber reinforcing
plies and also of the bead apex when measured at 70°C is the same as or
greater than 9 MPa, and the tanδ is equal to or smaller than 0.03
(measured by means of "EPLEXOR", 10 Hz, 10 % prestress and 1 % DSA)
as a result of the mixtures that are used and the hardening tim that is
selected. The hardness IRHD of these rubber reinforcing plies and also of
the bead apex should be equal to or greater than 80 when measured at

room temperature. The measurement of the IRHD (International Rubber Hardness Degree) thereby takes place analogously to the Shore hardness measurement, but with a ball like measuring tip. The measurement or testing thereby takes place in accordance with DIN 53519, with the so-called microhardness being determined, since small samples are measured which are taken from the respective tire.

The rubber reinforcing plies and bead apex are preferably manufactured from a rubber mixture which consists of a polymer mix of NR/IR and BR, with at least 50 parts of NR/IR being contained in this polymer mixture, a carbon black content of 50 to 60 parts, preferably a rapidly sprayable FEF carbon black, as well as 5 to 8 parts of zinc oxide, 2 parts of stearic acid, 1.5 parts of aging protecting agent and also one or more parts of vulcanization accelerator and sulfur (preferably 4 to 5 parts) in order to keep the loss characteristics of the mixture low.

An advantageous embodiment is characterized in that all rubber reinforcing plies taper to a tip at their free ends in cross-section.

In the event that the radially inner end of the outer rubber reinforcing ply is simultaneously formed as a bead apex, provision is made that, when measured in the region of the maximum bead thickness (side wall height W), the thickness of the inner rubber reinforcing ply is approximately 2.5 mm, the thickness of the middle rubber reinforcing ply is approximately 1.9 mm, and the thickness of the outer rubber reinforcing ply amounts to 6.9 mm, with a tolerance of +/- 0.5 mm applying for all measured valu s.

Further advantageous embodiments of the invention are set forth in the subordinate claims and will also be explained in the description of the embodiments.

The invention will be explained in more detail in the following with reference to embodiments and to the drawing, in which are shown:

Fig. 1   a schematic axially sectioned representation of one half of a centrally symmetrical tire,

Fig. 2   a schematic representation to explain the height and thickness dimensions of the rubber reinforcing plies used in the tire of Fig. 1, and

Fig. 3   a sectional representation of one half of a tire in accordance with a preferred embodiment of the invention.

In accordance with Fig. 1 the tire has a three-ply carcass comprising an inner carcass ply 1, a middle carcass ply 2 and a radially outer carcass ply 3.

The inner carcass ply 1 is guided around the bead 8 and its end region 11 extends at the outer side up to at least half the height of the bead apex 9 and is connected to the radially outer carcass ply 3 while forming an overlapping zone.

The middle carcass ply 2 ends axially inside the bead apex 9 and extends approximately up to the bead 8.

A first rubber reinforcing ply 4 is arranged radially inside the first carcass ply 1 and between this first carcass ply 1 and an inner rubber layer 7.
A second rubber reinforcing ply 5 is located between the first carcass ply 1 and the middle carcass ply 2, while a third rubber reinforcing ply 6 is arranged between the middle carcass ply 2 and the outer carcass ply 3.

The design of the rubber reinforcing plies with respect to their radial height and their thickness profile over the height, on the one hand, and the mixture used for the rubber reinforcing plies, on the other hand, are of important significance for the running performance of the tire in the deflated state and also for its behavior in normal running.

All rubber reinforcing plies 4, 5, 6 have a different height and in each case a different thickness profile over their height.

The rubber reinforcing plies consist of a rubber mixture of mix of NR and/or IR and BR, as well as carbon black, zinc white, stearic acid, aging protection agent, softener, sulfur and accelerator. The reinforcing plies and bead apex are preferably manufactured from a rubber mixture comprising a polymer mix of NR/IR and BR, with at least 50 parts NR/IR, a carbon black content of 50 to 60 parts, 5 to 8 parts zinc oxide, 2 parts of stearic acid, 1.5 parts of aging protection agent and also at least one part of vulcanization accelerator and sulfur. Preferably 4 to 5 parts sulfur are used in order to keep the loss characteristics of the mixture low.

The rubber mixture intended for the rubber reinforcing plies and the bead apex must be hardened in such a manner that the rubber reinforcing plies have the following characteristics in the finished tire:

6

Hardness IRHD greater than or equal to 80, measured at room
temperature,
modulus of elasticity (MPa) greater than or equal to 9 MPa and tanδ
smaller than or equal to 0.03, in each case measured at 70°C and by
means of "EPLEXOR", 10 Hz, 10 % prestress, 1 % DSA (Double Strain
Amplitude).

The IRHD measurement (International Rubber Hardness Degree) takes
place in accordance with the test method DIN 53519 sheet 2.

Fig. 2 shows a schematic representation to explain the length and
thickness profile of the three rubber reinforcing plies of an embodiment,
with the following table setting out the thickness profile relative to the
height in millimeters for each of the strips alongside the value of the
height.

	Height (mm)	Thickness 1 (mm)	2	3	4	5	6	7
Rubber ply 4	120	3.2	4.0	3.0	2.6	--	--	--
Rubber ply 5	110	2.4	3.4	3.8	3.2	--	--	--
Rubber ply 6	130	9.0	7.8	7.5	4.5	3.7	2.7	1.5

The tolerances amount in this respect to ± 3 mm for the height and to ± 0.3 mm for the thickness.

The positions 1 to 7 of the Table distributed over the side wall height can be found from Fig. 2.

Fig. 3 shows a sectional representation of one half of a preferred embodiment of a pneumatic vehicle tire in accordance with the invention. The basic construction of this tire corresponds to the embodiment of Fig. 1, but in this case the outer rubber reinforcing ply 6 is integral with, i.e. formed in one piece with, the bead apex 9.

In Fig. 3 measurement positions are entered accurately, as a result of which the important thickness values and positions for the invention can be specified.

The tire thickness A2 at the center of the crown preferably amounts to 17.5 ± 0.8 mm, whereas the tire thickness C2 at the shoulder amounts to 18.5 ± 1.0 mm at the position shown. The thickness Y of the bead amounts to 20.0 ± 1.5 mm at the position shown, whereas the bead thickness R1 amounts at the position shown, at the height of the dimension R, to 15.0 ± 1.5 mm.

The measurement of the bead thickness Y takes place at the level of the dimension W entered in the drawing.

For the function of the pneumatic vehicle tire of the invention the belt side position of the ends of the rubber reinforcing plies 4, 5, 6 is als of

8

importance. These rubber reinforcing plies extend beneath the belt 10 and also have different spacings with respect to the lateral belt end.

The corresponding distance A for the inner rubber reinforcing ply 4 amounts to 33.0 ± 2.5 mm, the distance B for the central rubber reinforcing ply 5 amounts to 22.0 ± 2.5 mm and the distance C for the outer rubber reinforcing ply 6 amounts to 15.0 ± 2.5 mm.

The rubber reinforcing plies 4, 5, 6 have over their radial height a characteristic thickness profile which can be seen from Fig. 3, which is characterized by the thickness values present in Fig. 3 at the measurement positions shown. At the measurement position D, which is disposed approximately at the level of 2/3 of the side wall height, the inner rubber reinforcing ply 4 has a thickness of 3.0 ± 0.5 mm, the central rubber reinforcing ply 5 has a thickness of 2.8 ± 0.5 mm and the outer rubber reinforcing ply 6 has a thickness of 2.9 ± 0.5 mm.

At the measurement position E at half the side wall height, the thickness of the inner rubber reinforcing ply amounts to 3.2 ± 0.5 mm, the thickness of the middle rubber reinforcing ply 5 amounts to 2.9 ± 0.5 mm and the thickness of the outer rubber reinforcing ply 6 amounts to 3.3 ± 0.5 mm.

At the measurement position Y the inner rubber reinforcing ply 4 has a thickness of 2.5 ± 0.5 mm in the plane shown, the middle rubber reinforcing ply 5 has a thickness of 1.9 ± 0.5 mm and the outer rubber reinforcing ply, which is simultaneously formed as the bead apex, has a thickness at this point f 6.9 ± 0.5 mm.

The thicknesses of the rubber reinforcing plies 4, 5, 6 change continuously between the values quoted with respect to the defined measurement positions.

It should also be mentioned that the distance between the steel belt and the aramid belt is increased by approximately 0.4 mm in comparison to a standard tire, in order to thereby achieve a further reduction of the bending deflection in the deflated state as a result of the thereby increased rubber component.